Popcorn Ash at Georgia Power Company's Plant Bowen; Experiences and Removal Strategies

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Summary

I. Introduction

A. Plant Bowen Facts:

Georgia Power's Plant Bowen has four CE (Alstom) T-fired units, operates at a total of 3200 MW, and burns Central Appalachian (KY) coal. Units 1 and 2 are each 770 MW units and were equipped with SCR systems in the spring of 2001. The SCRs are a 3+1 layer reactor design and are equipped with Cormetech 7.1 mm pitch honeycomb catalyst.

B. SCS Plugging History at Bowen:

The Bowen Unit 1 SCR was placed in service on 5/17/01 and the top catalyst layer differential pressure gradually increased from 0.7 to 4 inches H_2O. The SCR was removed from service on 7/24/01 after 69 days (~1650 hours) of service. The SCR was inspected and there was no significant ash buildup on the screens. However, the removal of the screens showed that the catalyst channels were plugged with popcorn ash and fly ash. There was a gradient of pluggage, with the worst pluggage being on the south wall (boiler side) of the reactor and the least pluggage being on the north side of the reactor. The SCR on Unit 2 was brought online in July of 2001 and operated for a total of 1464 hours after being brought offline due to a high differential pressure across the catalyst layers. At this time, all protective screens were removed from the catalysts and "in-situ" cleaning was performed by blowing from the bottom of the catalyst with compressed air while vacuuming on the top of the catalyst. This method proved to be ~50% effective and both units were brought back online for the remainder of the ozone season. After the ozone season, layers 1 and 2 of Unit 1 were replaced with new catalysts and Unit 2 was unchanged due to the lower amount of operating hours. In addition, baffle plates were installed in the economizer outlet area in order to capture larger popcorn ash particles. Both units were brought back online in May of 2002 and operated for the duration of the ozone season. The baffles decreased the amount of plugging but the catalysts continued to plug, only at a slower rate.

II. Technical Investigation

A. SCS Investigates Reasons Behind Plugging and Solutions to Plugging

There are varying opinions as to what mechanisms form popcorn ash, but there is no conclusive data as to which of these is the main contributor. One hypothesis is that popcorn ash develops from ash deposits on the boiler tubes that has hardened and broken off. This hardened “popcorn” ash is easily carried over into the SCR. Several other operating parameters may lead to popcorn ash formation, such as burner tuning, fuel line balancing, and many other boiler operational issues.

It became apparent that little could be done to affect the formation of the particles in the time frame available and that the economizer outlet baffles were unable to stop the carryover of 100% of the particles; therefore, a task force was formed to investigate new solutions to the popcorn ash issue. One of these solutions was to remove the plugged catalyst from the reactor and perform regeneration. Typically, regeneration refers to recovering catalyst activity, which in this case was lost due to plugged channels and thereby loss of specific surface area. The catalyst had no loss of chemical activity directly associated with the pluggage. The pluggage was simply preventing the flue gas from reaching the catalyst surface where the NO_x reduction reaction occurs. However, in spite of the pluggage, the SCRs on both units were still capable of maintaining the designed deNO_x performance levels.

B. Enerfab/Envirgy Perform Tests on Catalyst Samples

To investigate the possibility of regeneration, Southern Company researchers and engineers approached Envirgy to perform pilot tests. Single catalyst elements were shipped to Austria and were regenerated using Envirgy’s proprietary “oscillation” process. The results of the pilot test showed that it was possible to recover >95% open channels by this process. Logistically, the regeneration would be performed by Envirgy, in a team with Enerfab; therefore, additional tests were performed at Enerfab’s facility in Cincinnati. This test confirmed that the catalyst could be regenerated, but there were opportunities to make the process more efficient.

C. SCS Decides Upon Various Technology Steps for Solution

After witnessing the regeneration pilot tests, it was decided to remove and regenerate the first layer of Bowen Units 1 and 2, as well as the layers that were removed from Unit 1 in 2002. This decision was made based on cost, schedule, and the ability of the regeneration to be performed on site at Plant Bowen. Because of Enerfab’s capabilities, the removal and installation of the catalysts was performed by Enerfab which led to an efficient and flexible schedule. In addition to regeneration, protective screens were installed in the inlet duct to the SCR prior to the 2003 ozone season and catalyst layers 2 and 3 were cleaned by the previously mentioned “in-situ” method.

D. Contract Guarantees

The following guarantees were required to be met by Enerfab and Envirgy. The catalyst would be restored to >90% open channels and there would be no influence on chemical and physical properties of the catalyst. The removal, regeneration, and installation of layer 1 of both units were to be completed in ten weeks according to the contract.

III. Catalyst Regeneration Process

Due to the varying types of deactivation, there are several different combinations of regeneration steps that are modified according to the specific application. All of these steps are unique developments of Envirgy. The combinations of steps used for this particular regeneration project are as follows. The initial step consists of vacuuming all loose fly ash off of the top of each catalyst module. This step omits the extensive use of washing solution and minimizes waste water in the washing process. After vacuuming is complete, it is more feasible to inspect the catalyst modules for any mechanical damages. The next step of the regeneration process is a smooth oscillation washing of the catalyst in an aqueous solution. This is the main step to remove loose fly ash that has been packed in the catalyst channels. After the oscillation, the catalyst modules are aerated. This step proved very effective in removing the popcorn ash from the catalyst channels. After the washing steps are complete, the module is removed from the bath and sent to the drying process. This process consists of a heater which removes the surface humidity from the catalyst. After a final inspection and acceptance by the customer, the catalyst is ready for re-installation into the SCR reactor.

IV. Catalyst Regeneration Results and Conclusions

As the primary reason for regeneration, the catalyst channels were restored to >95% open on average. In addition, the physical and chemical properties of the catalyst were still within the range of the original catalyst contract guarantees. The catalyst activity was fully recovered to the expected value, and the SCRs were ready to operate by the beginning of the 2003 ozone season. These successful results have been confirmed by the SCR operation during 2003 which to date has been at the desired NO_x reduction levels.